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Tax Competition and Tax Harmonization with Evasion*

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Abstract

We examine a two-jurisdiction tax competition environment where local governments can only imperfectly monitor where agents pay taxes and risk-averse individuals may choose to cross borders to pay lower taxes in a neighboring location.

In the game between local authorities, when communities differ in size, in equilibrium the smaller community sets lower taxes and attracts agents from the larger jurisdiction. With identical communities, tax rates must be equal. Whenever the smaller community benefits from tax harmonization, the larger one will also.

If the high-tax community chooses a monitoring policy, the local population splits into groups of tax avoidance and compliance.

JEL Classification: H20, H26, H30, H77.
Keywords: Tax Competition, Tax Evasion, Tax Harmonization, Risk-Aversion

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1 Introduction

In this paper we examine an environment where local authorities compete to maximize revenues from residence-based personal taxation and where individuals have the ability to evade taxes via illegal cross-border shopping, i.e., individuals can choose in which community to pay their contributions by lying about their place of residence. Local governments can verify if individual agents have paid taxes, but can only imperfectly monitor if they do so in their community of residence. Residents in each community are ordered in terms of risk aversion and face different incentives towards tax evasion; governments in each jurisdiction take the residents' choices into account when setting tax rates.

Examples of illegal cross-border shopping to avoid taxes in the United States include smuggling of alcohol and tobacco across state borders. Although the consumption of alcohol and tobacco is not illegal, in many instances shipping these goods across state borders is. Empirical studies suggest that cross-border shopping of alcohol and tobacco is a significant factor in explaining sales differentials between U.S. states; see for example Saba et al. (1995), Crawford and Tanner (1995), and Beard et al. (1997). This evidence suggests that cross-border shopping may hinder the ability of local and state governments to raise tax revenues. Recently, the popular press has remarked on the potential impact of on-line trade on avoidance of state sales taxes. In the international context, cross-border shopping across countries appears to be a significant source of evasion of value-added tax. Gordon and Nielsen (1997), for example, compare tax evasion in an open economy under regimes of value-added and income taxation.

One way of analyzing this issue is by modeling competition among states that strategically account for the cross-border shopping induced by tax differences across locations. In our framework we characterize the individual decision of whether to evade taxes under the assumption of risk aversion. We examine the implications of size and income differences across communities on the relative tax rates set by rival locations. We extend existing results in the literature that small communities set lower taxes in equilibrium to the case of risk-averse agents; the reason is that small communities generate more revenues by attracting tax evaders from the large community, which more than compensates what they give up from their tax base at home. We examine the conditions under which harmonization to a common tax policy benefits each location and their incentives to reach an agreement. Finally, we explore the problem of designing a monitoring policy for the high-tax community.

In the literature on tax competition, Bucovetsky (1991) and Wilson (1991) analyze the effects of jurisdiction size on the equilibrium tax rates and find analogous results in a representative agent framework. In a spatial competition framework, Kanbur and Keen (1993) and Ohsawa (1999) are particularly interested in identifying which countries choose to become tax havens. They obtain analogous results for the case of risk-neutral individuals. These approaches do not examine tax evasion.

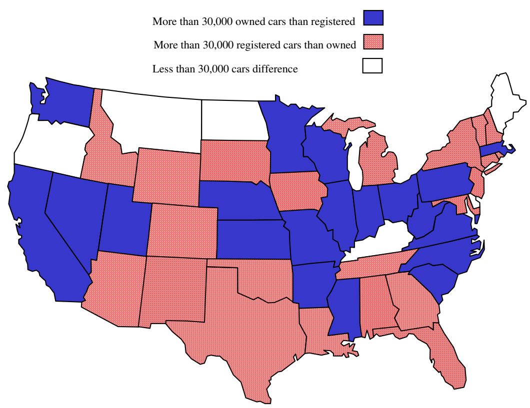
Cremer and Gahvari (2000) is the only other study of evasion in a model of tax competition we are aware of that is close to ours. They examine economic integration of countries which have two different types of evasion behavior for their residents, and individuals may only evade taxes if the country's type is "dishonest". They analyze tax evasion within the countries in the economic union; their motivation is similar to ours, but in their framework agents are risk neutral, as in Kanbur and Keen (1993). In our model, residents in either location can cross-border shop to avoid high taxation, and evasion is modeled as an individual's choice problem. .

Another instance of cross-border shopping in the United States is the system of car registration fees. States demand that every vehicle displays a license plate in order to circulate, and since registration fees may differ across local or state governments, agents may illegally choose to register their car in a neighboring low-tax community (which may require vehicle owners to produce proof of residence in that community). It is easy to verify that a car owner has paid registration fees somewhere, but there is no easy way to check where motorists actually drive their cars, since local authorities do not know if a car with out-of-state plates has been in the state for one week or one year. There are, however, penalties for perpetrators that are caught. Given a monitoring technology, the individual decision problem can be modeled as a binary choice problem of choosing to pay taxes at home or facing the gamble of paying taxes in the low-tax community, with possible legal repercussions. The intuition of treating tax evasion as a lottery was first developed by Allingham and Sandmo (1972) and has been widely used in the literature on income tax evasion.

Casual evidence suggests that this problem may be of some relevance. For example, the Minneapolis *Star Tribune*[1] reports that "an estimated 35,000 Minnesotans have illegally registered their cars in neighboring states, mostly in Wisconsin, which has lower annual registration fees." This represents, they say, a loss of approximately $3.5 million in the state's highway trust fund, to which total registration fees contribute 47% (almost $450 million). License tabs for cars in Minnesota range from $35 to about $475, while Wisconsin has a flat fee of $45. If prosecuted, individuals face sentences of up to one year in jail and a $3,000 fine. *The Boston Globe*[2] relates the case of Massachusetts and New Hampshire: insurance costs in Massachusetts are much higher than in New Hampshire, where auto insurance is not

[1] *Star Tribune*, January 3 1999.
[2] *The Boston Globe*, January 28 and April 6, 1999.

Figure 1: Owned Cars vs Registered Cars by State



even required until the first accident occurs. *The Boston Globe* also relates the concern of the Insurance Fraud Bureau, which estimates the costs in lost insurance, taxes, and fees to the state at about $1,200 a year per unregistered car.

Comparing the pattern of registered cars in the United States with the number of cars people reported owning in the 1990 Census, some states appear to show an influx of cars from other states. Massachusetts, in particular, seems to be surrounded by receptor states. The map in Figure 1 shows the number of registered cars by state compared against the number of cars owned by households in 1990.[3]

In South America, Uruguayan states are found to behave strategically when setting car registration fees. Statistical evidence suggests that differences in community sizes and income distribution are relevant in determining the outcomes. Montevideo, by far the largest community, has historically set higher fees than other municipalities. In 1995, traffic inspectors monitored the main street access to downtown Montevideo and found that 40% of the cars were from other communities. Maldonado, a small municipality, seems to have received an important share of tax evaders over the years. The different municipalities have signed cooperation agreements in setting registrations fees, but local governments have continued competing with various discount schemes for tax payments. The only community that has rejected the agreements and has continued fixing lower fees is the smallest of all communities.

The outline of this paper is as follows: We introduce the model in section 2, the agents' decision problem in section 2.1, and we state the game between the local governments and define an equilibrium concept in section 2.2. In section 3 we characterize the properties

[3]Registration data were obtained from Highway Statistics 1990 and are based on states' registration records. The number of cars owned by households was obtained from the reports to the 1990 Census of Population and Housing. We computed the difference between these two series.

of pure strategy equilibria for identical and different communities. Then in section 4 we analyze the incentives of communities to harmonize tax rates and the benefits this may imply. We analyze the optimal monitoring policy of a high-tax location in section 5. Finally, we conclude in section 6.

2 The Model

There are two communities, each populated by a continuum of agents who differ in levels of income, y, that is measured in units of a private consumption good. Income distribution in each community is defined on the support $[\underline{y}, \overline{y}]$ and is characterized by a continuous density function $\psi_i(y) = N_i\phi(y)$, where $\int \phi(y)dy = 1$ and $N_i > 0$, for $i = 1, 2$, denotes the population size. We use Φ to denote the cumulative distribution function of the density ϕ.

Individuals in each community have preferences over net income. We assume that the utility function, u, representing preferences, satisfies $u' > 0$, $u'' < 0$, and decreasing absolute risk aversion (henceforth referred to as DARA).

Local governments fix residence-based head taxes, T_i. Local governments can verify if individuals contribute or not, but not if they do it where they are supposed to because agents may choose to declare residence in a neighboring community, if it requires a lower tax, and pay taxes there. If an individual decides to evade taxes he takes into account the local government's monitoring efforts, represented as a constant audit probability, $\pi \in (0, 1)$. The penalty for evasion is having to pay a constant fine, $F > 0$. Fines could be different across communities, but we assume they are not choice variables (presumably, they are imposed by a federal authority). For simplicity, we assume fines are the same across locations. Finally, we assume that local governments are Leviathans: their objective is to maximize revenues from taxation and penalties from perpetrators that are caught.

The model describes competition among communities for fiscal revenue by means of a non-cooperative two-stage game. In the first stage local governments announce taxes rates and in the second stage individuals make decisions on where to pay taxes.

2.1 The Decision Problem of Individuals

Given announced policies in both communities (T_1, T_2), individuals have to decide whether to pay taxes at home or lie about their place of residence and pay taxes in the rival location. In what follows, we assume that the monitoring technology is the same across locations. An individual in community 1 with income y derives utility $u(y - T_1)$ if he decides to pay at home. If he lies, his expected utility is $(1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)$.

Remark 1 *A necessary condition for tax evasion in community 1 is $T_2 < T_1$. A sufficient condition is $T_2 + F \leq T_1$.*

Clearly, the interesting case to discuss is when $T_2 < T_1 < T_2 + F$, since we may have $u(y - T_1) \lesseqgtr (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)$. The following two propositions refer to this case.

Proposition 1 *For any configuration of taxes (T_1, T_2), and for each community i, there exists a unique cut-off income level, $y_i^* \in [\underline{y}, \overline{y}]$, such that every agent in community i with $y \geq y_i^*$ decides to evade, and those with $y < y_i^*$ decide not to.*

Proof. Examine the problem of an agent in community 1. For any $y \in [\underline{y}, \overline{y}]$, define $c(y, T_2)$ to be the certainty equivalent of the evasion lottery, i.e., the level of net income such that $u(c(y, T_2)) = (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)$. An agent with income y will not evade if and only if $u(y - T_1) > (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)$; by the definition of $c(y, T_2)$, this is equivalent to requiring that $y - c(y, T_2) > T_1$. Since u satisfies DARA, $y - c(y, T_2)$ is strictly decreasing in y, and $\check{y}$ such that $\check{y} - c(\check{y}, T_2) = T_1$ is unique when it exists. Define y_1^* by:

$$y_1^* = \begin{cases} \underline{y} & \text{if} \quad \underline{y} - c(\underline{y}, T_2) \leq T_1 \\ \overline{y} & \text{if} \quad \overline{y} - c(\overline{y}, T_2) \geq T_1 \\ \check{y} & \text{if} \quad \underline{y} - c(\underline{y}, T_2) > T_1 \text{ and } \overline{y} - c(\overline{y}, T_2) < T_1. \end{cases} \tag{2.1}$$

Thus y_1^* is unique and satisfies the required properties; y_2^* is defined analogously. ■

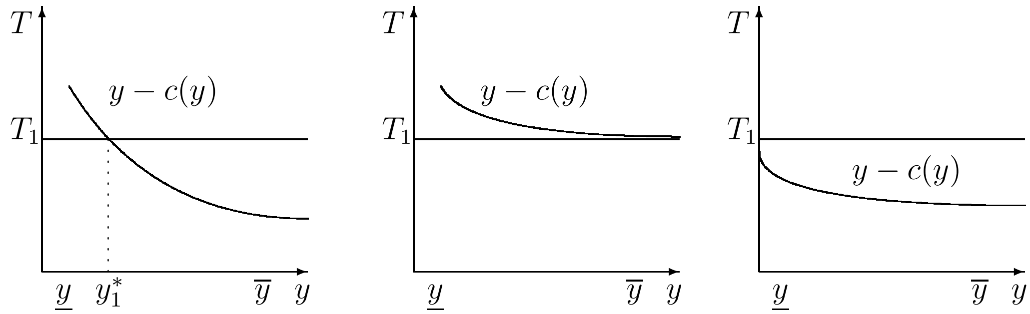
There are three cases shown in Figure 2.[4] In case B there is no tax evasion, in case C everybody evades, and in case A only the rich do. The individual with income level $y = y_1^*$ is indifferent. If $y_1^* = \overline{y}$, there is no tax evasion. According to this proposition, if in equilibrium there is any tax evasion in a community, it is the rich agents who evade. This result is analogous to the spatial competition models of Kanbur and Keen (1993) and Ohsawa (1999), in which individuals with the lowest transportation cost, i.e., those closest to the border, are the ones more likely to evade.

The cut-off income level, y_1^*, satisfies the following:

Proposition 2 *y_1^* is non increasing in T_1 and non decreasing in T_2.*

[4] Given that $u' > 0$, by the inverse function theorem, u^{-1} exists and is differentiable, thus c is continuous and differentiable in y.

Figure 2: Evasion Decisions



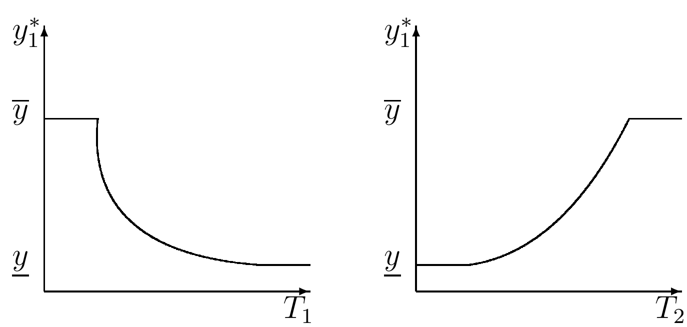
Case A: The Rich Evade Case B: Nobody Evades Case C: Everybody Evades

Proof. It is enough to prove the result for an interior $y_1^* \in (\underline{y}, \overline{y})$. In this case, the implicit function theorem implies that y_1^* is continuous and differentiable, and we have

$$\frac{\partial y_1^*}{\partial T_1} = \frac{u'(y_1^* - T_1)}{u'(y_1^* - T_1) - (1-\pi)u'(y_1^* - T_2) - \pi u'(y_1^* - T_2 - F)} < 0.$$

The sign follows because the numerator is positive and the denominator is negative by lemma 1 in the appendix. We can show that $\frac{\partial y_1^*}{\partial T_2} > 0$ in the same manner. An analogous result can be established for y_2^*. ■

Figure 3: Characterization of y_1^*



Intuitively, when the tax difference is larger, poorer agents can afford to take the risk of evading. If the gains from evasion are small, only the richest people will be able to afford choosing the implied lottery of tax evasion. See Figure 3. Clearly, if taxes coincide there is no incentive to evade.

2.2 Game Between Local Governments

Local governments set their taxes strategically in a two-stage game. In the first stage, they announce their policies; in the second stage, individual decisions on tax evasion determine the tax base in each community.

The solution concept is subgame perfection. An equilibrium is characterized by backward induction replacing the decision rules of individuals—represented by cut-off levels of income y_i^*—in the objective functions of the local governments. The values y_i^* determine who evades taxation in each location. The tax base is formed by local agents who do not evade and foreign agents who evade in their community of origin. In addition, fines are collected from local agents who evade and are caught; by the law of large numbers, they represent a fraction π of tax evaders.

The revenue function of local government 1 is given by the following expression:

$$R_1\left(T_1, T_2\right) = \begin{cases} \{N_1 + N_2[1 - \Phi(y_2^*)]\}T_1 & \text{if} \quad T_1 \leq T_2 \\ N_1\Phi(y_1^*)T_1 + N_1[1 - \Phi(y_1^*)]\pi F & \text{if} \quad T_1 \geq T_2, \end{cases} \tag{2.2}$$

where $\Phi(y_i^*)$ is the fraction of individuals that evade taxes in community i.

Definition 1 *A pure strategy equilibrium for this environment is a tax for each community,* (T_1, T_2) *cut-off income levels,* y_1^* *and* y_2^**, such that:*
i) T_i *solves the problem of community* i *given the policy of the other community,* T_j*, for* $i, j = 1, 2$, $i \neq j$*, and aggregate decision rules, summarized by cut-off levels* y_1^* *and* y_2^**,*
ii) income levels y_1^* *and* y_2^* *are determined consistently with individual decision problems when residents take policies* (T_1, T_2) *as given.*

The above definition of equilibrium corresponds to the Nash equilibrium of the reduced game defined by incorporating agents' best responses to announced governments' policies in the payoff functions of the local governments: $\Gamma_N = [I, \{S_i\}, \{R_i\}]$, where $I = \{1, 2\}$ is the set of communities or local governments; $S_i = \left[0, \overline{T}\right] \subset \Re$ is the set of strategies for local government i, and R_i is the payoff defined in equation (2.2).[5] It is easy to see that the payoff functions in our problem need not be concave because of the endogenous determination of the tax base. In such cases, there are no general results guaranteeing existence of pure strategy equilibria. However, mixed strategy equilibria are shown to exist in Glicksberg (1952) under continuity of the payoff functions alone.[6] In what follows we will examine properties of pure

[5]Notice that given the structure of the model, in order to guarantee non-negativity of net income for the lowest income type, we have to define a maximal tax $\overline{T} < \underline{y}$.

[6]In our case, the objective function R_i is continuous if the cut-off levels y_i^* are continuous and the income distribution function has no mass points. In the appendix we show y_i^* is continuous.

strategy equilibria when they exist, in particular, the way policies determine the mobility of the tax base through the tax evasion decisions of individuals.

3 Size Effects on Policies

In the model, communities may differ only in the size dimension. In this section, we ask whether small communities set lower taxes in equilibrium. In order to examine the effects of differences in community size, we allow for differences in total mass, N_i. It turns out that having a smaller population allows locations to gain by undercutting the rival's tax rate and attracting a large mass of evaders. The large location, in contrast, has more to lose by attempting to undercut the smaller rival because of its own large base.

3.1 Identical communities: $N_1 = N_2$

With identical communities we could imagine that an asymmetric situation could be an equilibrium: for example, one community sets lower taxes and attracts the top portion of the population of the rival community, which sets a higher tax on its reduced base. But this intuition is not correct, as shown in proposition 3: with equally sized communities there cannot be an asymmetric equilibrium in pure strategies.

Proposition 3 *If $N_1 = N_2 = N$, then in any equilibrium (T_1, T_2), $T_1 = T_2$.*

Proof. Suppose there is an equilibrium with $T_1 \neq T_2$. Without loss of generality, let $T_1 > T_2$. Lemma 2 in the appendix then implies that $T_1 - T_2 > \pi F$. Since (T_1, T_2) is an equilibrium, we must have

$$\begin{aligned} R_1(T_1, T_2) &\geq R_1(T_2, T_2) \\ R_2(T_1, T_2) &\geq R_2(T_1, T_1). \end{aligned}$$

Adding these inequalities we obtain

$$N\Phi(y_1^*)T_1 + N(1-\Phi(y_1^*))\pi F + NT_2 + N(1-\Phi(y_1^*))T_2 \geq NT_2 + NT_1,$$

which is equivalent to

$$-(1-\Phi(y_1^*))(T_1 - T_2) \geq -(1-\Phi(y_1^*))\pi F.$$

Notice that $(1-\Phi(y_1^*)) > 0$, i.e., there is some evasion, otherwise, by the same argument as in lemma 2, it would pay jurisdiction 2 to raise its tax rate. Then $T_1 - T_2 \leq \pi F$, a contradiction. ■

It turns out that the only possibility for equilibrium in pure strategies with identical communities is the one in which governments set maximal taxes, as implied by the next result.

Proposition 4 *Assume $F > 0$ and $\pi > 0$. If there exists a symmetric equilibrium in pure strategies, (T, T), it must be that $T = \overline{T}$.*

Proof. Suppose (T, T) is an equilibrium and $T < \overline{T}$. In this situation there is no evasion, since, for any agent with income y in either community,

$$u(y-T) > (1-\pi)u(y-T) + \pi u(y-T-F).$$

Because the inequality is strict, either community can slightly increase its tax without inducing any evasion and increase its revenue. Therefore (T, T) could not have been an equilibrium. ■

The difficulty in finding equilibria where tax rates are not maximal lies in the assumption that all individuals must pay taxes. If local governments allowed individuals for whom net income became negative to be exempt from taxation, it might then be possible to find pure strategy equilibria where taxes fall below the highest income level. This extension would require using exceptional qualifications for tax evaders, for example, when an individual is only constrained if he gets caught.

3.2 Different communities: $N_1 > N_2$

Casual evidence suggests that larger (or more densely populated) communities tend to set higher taxes. Smaller communities, by fixing a lower tax, can generate extra revenue collected from tax evaders attracted from the rival community—at the cost of losing revenue from the local population. Intuitively, small communities have more to gain from attracting a larger mass of tax evaders, because the density of their own tax base is small. In our model when community sizes differ, the larger community does not set the lower tax.

Theorem 1 *When locations differ in size, the smaller community will set the smaller tax rate, i.e., $(N_1 - N_2)(T_1 - T_2) > 0$.*

Proof. Let $\theta = N_1/N_2$. Without loss of generality, let $T_1 > T_2$.
In equilibrium we must have,

$$\begin{aligned} R_1(T_1, T_2) &\geq R_1(T_2, T_2) \\ R_2(T_2, T_1) &\geq R_2(T_1, T_1). \end{aligned} \tag{3.1}$$

Expanding we can express these inequalities as

$$\begin{aligned} \theta T_1 \Phi(y_1^*) + \pi F \theta[1 - \Phi(y_1^*)] &\geq \theta T_2 \\ T_2 + T_2\theta[1 - \Phi(y_1^*)] &\geq T_1. \end{aligned}$$

Adding the expressions and manipulating we obtain:

$$(\theta - 1)(T_1 - T_2) \geq (T_1 - T_2 - \pi F)\theta[1 - \Phi(y_1^*)]. \tag{3.2}$$

The argument in lemma 2 implies that when $T_1 \neq T_2$, in equilibrium we must have $|T_1 - T_2| > \pi F$, it also implies that there is some evasion, i.e., $(1 - \Phi(y_1^*)) > 0$, and therefore the result follows. ■

The smaller jurisdiction therefore has strong incentives to undercut its larger rival's rate to induce evasion in that community. Intuitively, in order to sustain evasion in equilibrium, the difference in tax rates has to exceed the expected payment of fines.

An interesting question that arises is whether a similar result can be established if instead of examining large and small communities, we looked at rich vs. poor jurisdiction, as it is often done when analyzing population migration models in the spirit of Tiebout (1956). It turns out that examining the effects of differences in income distribution, normalizing $N_1 = N_2 = 1$ and allowing the density functions, ϕ_i, to vary, does not yield a clear characterization, as in the case of size differences. If we define community 1 to be richer than community 2 when $\Phi_1(x) \leq \Phi_2(x)$ for all $x \in [\underline{y}, \overline{y}]$, there are two opposing effects. Taking the tax rate of the rich community as given, the poor community by fixing a lower tax can attract the top portion of the rich community—a stealing effect—but it can also set a higher tax to increase local revenues, knowing that its local agents will probably not take the chances of evasion—a capturing effect. In general, it is not possible to determine which effect dominates.[7]

[7]For example, let community 1 have a degenerate distribution at some income level, $\widehat{y}_1$, then it has to be that $T_1 \leq T_2$. In an equilibrium with $T_1 > T_2$ there cannot be any tax evasion in community 1. The reason is that since all individuals are identical, tax evasion would imply that everyone evades and revenues are zero. The government in community 1 could then increase revenues by setting the same tax as the rival community. Now, because there is no evasion in community 1, $R_2(T_1, T_2) = T_2 < R_2(T_1, T_1) = T_1$, a contradiction.

4 Tax Harmonization

In this section we are interested in the possibility and the effects of tax harmonization. In a strict sense our analysis is not a welfare analysis since we will focus only on fiscal revenue. We want to know (1) whether it is possible (in the sense of individual rationality) to implement a harmonization policy over taxes, (2) under what conditions would this be possible, and (3) how would this affect revenue collection in both communities.

4.1 Harmonization with Transfers

First we restrict our analysis to the possible joint revenue gains from harmonization to a common tax rate, T^h, without discussing for the moment the incentives of each community to deviate from the agreement. We can think of this harmonization scheme as imposed by a federal government with the local governments forced to compel or as an agreement with transfers between communities.

Let (T_1, T_2) be an equilibrium for $N_1 > N_2$. Let T^h be the harmonized common tax rate. To facilitate exposition we will abbreviate notation in the following way:

$$\begin{aligned}
R_i &= R_i\left(T_1, T_2\right) \\
R_i^h &= N_i T^h \\
\Phi &= \Phi(y_1^*) \\
\theta &= \frac{N_1}{N_2}.
\end{aligned}$$

Therefore,

$$\begin{aligned}
R_1 &= N_1 \Phi T_1 + N_1\left(1-\Phi\right)\pi F \\
R_2 &= N_2 T_2 + N_1\left(1-\Phi\right) T_2.
\end{aligned}$$

It is not obvious that a harmonized common tax rate will lead to maximal joint revenues since it may be optimal (for a joint revenue maximizer) to allow some evasion with differentiated tax rates, given that there is a percentage π of all evaders that end up paying the tax rate of one community plus the fine of the other.

It turns out that if transfers can be implemented between communities, there is always a minimum common tax rate such that both communities benefit from harmonization and it is intermediate to the tax rates in the non-cooperative equilibrium.

Note that we made no assumption on the income level of community 1. In particular the example holds if $\widehat{y}_1 = \overline{y_2}$ or $\widehat{y}_1 = \underline{y_2}$.

Proposition 5 *Let* $\widetilde{T} \equiv \Phi T_1 + (1-\Phi)(T_2 + \pi F)$*, then communities will benefit from harmonization if and only if* $T^h \geq \omega \widetilde{T} + (1-\omega) T_2$*, where* $\omega \equiv \frac{\theta}{1+\theta}$.

Proof. Note that

$$
\begin{aligned}
R_1 + R_2 &= N_1 \Phi T_1 + N_1 (1-\Phi)(T_2 + \pi F) + N_2 T_2 \\
R_1^h + R_2^h &= N_1 T^h + N_2 T^h.
\end{aligned}
$$

Then $R_1^h + R_2^h \geq R_1 + R_2$ if and only if $N_1 \Phi \left(T^h - T_1\right) + N_1 (1-\Phi)\left(T^h - T_2 - \pi F\right) + N_2 \left(T^h - T_2\right) \geq 0$. Since $T_1 > T_2 + \pi F$, again by lemma 2, a necessary condition is $T^h > T_2$; then simply solving for T^h gives the desired condition. ■

It is interesting that the minimum harmonization tax rate required to guarantee larger joint revenues than those in the non-cooperative equilibrium is strictly between the two non-cooperative tax rates. The reason is that coordinating to an intermediate tax rate may be politically more feasible than imposing the maximal tax rate, $\overline{T}$, which would obviously maximize joint revenues subject to the constraint of requiring a common tax rate. If an intermediate tax rate is chosen, however, we will see that community 2 has to be compensated.

4.2 Harmonization without Transfers

If transfers between communities cannot be implemented, possibly because they are costly in terms of coordination or because the political implications are not desirable for the local governments, in order for jurisdictions to agree on harmonizing policies, individual revenues need to improve for both locations. In this subsection we do not present a theory of why this happens, we take this fact as given and provide conditions under which harmonization is beneficial or harmful to communities when side transfers are not allowed. Thus we impose that each community has to be at least as well off with the harmonized tax than in the non-cooperative equilibrium. This harmonized taxation may be the result of explicit negotiations between communities or we can think of it as an implicit collusion outcome of the game played repeatedly over infinite periods with a sufficiently high discount factor.[8]

Proposition 6
a) Neither community benefits from a harmonized tax rate lower than the smaller community's non-cooperative tax rate.
b) If (T_1, T_2) *is an equilibrium with* $T_2 < T_1$*, the smaller jurisdiction never benefits from a harmonization scheme that sets a common tax rate* T^h *with* $T_2 \leq T^h \leq T_1$.

[8]In the short run communities have an incentive to deviate. Therefore harmonized taxation is a subgame perfect Nash equilibrium only if the present value of future losses from not cooperating today is high enough.

Proof. a) The smaller jurisdiction does not benefit since it will not collect taxes from evaders and it is collecting lower taxes from its own residents. With respect to the larger jurisdiction, note that for $T^h < T_2$ it is the case that

$$R_1(T_1, T_2) \geq R(T_2, T_2) = N_1 T_2 \geq N_1 T^h,$$

where the first inequality follows from T_1 being a best response to jurisdiction 2 fixing a tax rate of T_2. Therefore the larger community does not benefit from taxes below T_2 either.

b) If we harmonize to the larger tax rate, $T^h = T_1$, then clearly,

$$R_2(T_1, T_2) \geq R_2(T_1, T_1) = N_2 T_1,$$

because T_2 is a best response to T_1. If we harmonize to the smaller tax rate, then

$$R_2(T_1, T_2) = N_2 T_2 + N_1 (1 - \Phi) T_2 > N_2 T_2 = R_2(T_2, T_2).$$

Now, if we harmonize to an intermediate tax rate, T^h,

$$R_2(T_1, T_2) \geq R_2(T_1, T_1) = N_2 T_1 \geq N_2 T^h = R_2(T^h, T^h).$$

■

This result is analogous to proposition 9 in Kanbur and Keen (1993), where a similar problem is analyzed with risk-neutral individuals. We now give conditions under which harmonization would garner benefits for both communities.

Proposition 7 *If there can be no transfers between jurisdictions, communities can benefit from harmonization if and only if*

$$T^h > max\{T_2 (1 + (1 - \Phi) \theta), T_1\}.$$

Proof. We need the fiscal revenues of each community in the harmonized scheme to be larger than in the non-cooperative case. Consider first the small community: $R_2^h > R_2$ if and only if

$$N_2 T^h > N_2 T_2 + N_1 (1 - \Phi) T_2.$$

But by proposition 6, the smaller jurisdiction will not benefit if the harmonized tax rate is not greater than T_1, therefore the stated condition must hold. The larger community will also benefit, since $R_1^h > R_1$ if

$$N_1 T^h > N_1 \Phi T_1 + N_1 (1 - \Phi) \pi F,$$

and by lemma 2 in the appendix this holds since $T_1 > T_1 - T_2 > \pi F$, and therefore $T^h > T_1 = \Phi T_1 + (1 - \Phi) T_1 > \Phi T_1 + (1 - \Phi) \pi F$. ■

The larger jurisdiction would benefit from harmonization with a tax rate even smaller than T_1 since evasion would be prevented in the harmonized environment. The necessary condition for the larger community to benefit from a harmonized tax rate is

$$T^h \geq T_1 - [1 - \Phi][T_1 - \pi F],$$

but a common tax rate equal to the right-hand side would harm the smaller jurisdiction. The premium the small jurisdiction has to receive in terms of a higher common tax rate is proportional to the fraction of evaders from the large location in the non-cooperative equilibrium. Therefore whenever the smaller community agrees to harmonize taxes, the larger one will as well.

5 Optimal Monitoring

In this section we consider situations in which communities have already committed to a tax policy and now have to choose optimal monitoring, which is costly.

Monitoring determines the risk that individuals face in the case of evasion. In our previous environment, when a given monitoring policy is less stringent, communities face a more elastic tax base, which implies tougher competition. Local governments respond by lowering taxes to reduce the incentives to evade. In the extreme case of no monitoring effort, undercutting may lead to cut-throat competition. Intuitively, if either the (fixed) probability of getting caught or the penalties are equal to zero across locations, whenever taxes differed, everyone in the high-tax location would choose to evade. Thus in equilibrium taxes would have to be equal because the tax base is perfectly mobile. Undercutting—in a Bertrand competition spirit—then would drive tax rates to zero. Revenue collection in such a case would be zero in each community.

In what follows we assume that the probability of getting caught is a policy instrument for the local communities, given now fixed tax policies across locations.[9] We also assume

[9] In the 1998 agreement between communities in Uruguay, taxes were fixed for each location and the only variable still under the control of local governments was their monitoring effort.

there is a per capita cost of monitoring, given by an increasing function $m(\pi)$.

We assume $T_1 > T_2$ and $T_1 < T_2 + F$ so that it is possible to induce at least some agents not to evade. Clearly, community 2 will not monitor because it has the lower tax, so the focus is on community 1.

5.1 Homogenous Monitoring

Suppose local governments are not able to set different levels of monitoring in terms of income level. In this situation, given the fixed tax rates in each community, local revenues as a function of the monitoring probability are given by

$$R_1(\pi; T_1, T_2) = N_1\Phi(y_1^*(\pi; T_1, T_2))T_1 + \pi F N_1[1 - \Phi(y_1^*(\pi; T_1, T_2))] - N_1 m(\pi). \tag{5.1}$$

The optimal level of monitoring is characterized by the following first-order condition:

$$[T_1 - \pi F]\,\phi(y_1^*(\pi; T_1, T_2))\frac{\partial y^*}{\partial \pi} + F[1 - \Phi(y_1^*(\pi; T_1, T_2))] = \frac{\partial m(\pi)}{\partial \pi}, \tag{5.2}$$

where the response of the cut-off level, y_1^*, to changes in the probability of being caught is

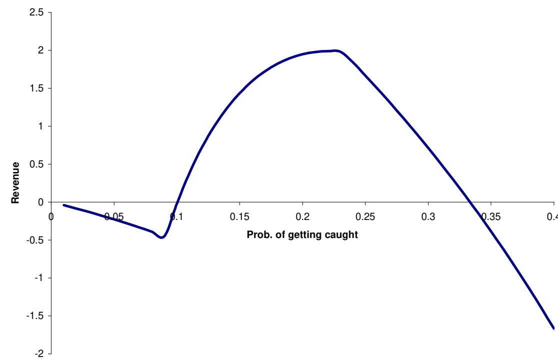
$$\frac{\partial y_1^*}{\partial \pi} = \frac{u(y_1^* - T_2 - F) - u(y_1^* - T_2)}{u'(y_1^* - T_1) - (1 - \pi)u'(y_1^* - T_2) - \pi u'(y_1^* - T_2 - F)} < 0. \tag{5.3}$$

The left-hand side in (5.2) shows the marginal benefit of increasing the level of monitoring. The first term indicates the net marginal gain from having evaders pay taxes instead of fines, and the second term is the increase in fines collected from perpetrators that are now more likely to get caught. The right-hand side represents the marginal cost of increasing the level of monitoring.

The next example illustrates the case of a high-tax community optimally choosing a constant monitoring policy. As would be expected, it is optimal for this community to allow some level of evasion. In Figure 4 we show the revenues as a function of the audit probability π.

- $N_1 = N_2 = 1$
- $\phi_1(y) = \phi_2(y) = \left(\frac{\overline{y}\underline{y}}{\overline{y} - \underline{y}}\right)\frac{y}{y^2}$ with $\underline{y} = 10$ and $\overline{y} = 150$
- $u(y) = \frac{1}{b-1}(a + by)^{1-\frac{1}{b}}, a = 2, b = 0.2$
- $m(\pi) = 10\frac{\pi}{(1-\pi)}$

Figure 4: Optimal homogeneous monitoring



- $F = 6$, $T_1 = 5$, $T_2 = 3.5$

In this community, the optimal monitoring policy, $\pi = 0.2208$, results in an income cut-off value of $y_1^* = 89.54$. Given the Pareto distributions we assumed, this implies that the top 4.82% of agents in community 1 decide to evade taxation.

5.2 Differentiated Monitoring

It is desirable to analyze the possibility of having monitoring depend on income levels. If it were possible to implement such a policy, it is clear that there would have to be a positive level of monitoring for all income levels in the high-tax community, since otherwise whoever is not monitored will evade. To get some intuition, consider initially a fixed monitoring policy, π, which results in an interior cut-off income level, y_1^*. The local government may increase net revenues by changing to a variable monitoring policy, $\pi(y)$. A variable policy would allow the government to lower costs of monitoring agents with income levels below y_1^*, without inducing them to evade, but it would be costly to induce agents with incomes above y_1^* not to evade. The optimal monitoring policy for each income level in this environment is obtained comparing the net benefits of collecting taxes or expected fines for each individual. Intuitively, there may exist an income level $\widehat{y}_1$ such that it does not pay community 1 to prevent agents with $y \geq \widehat{y}$ from evading. The local government should set a monitoring policy for these agents who evade so as to maximize expected revenue from fines.

In the region of income levels where the government induces compliance, it will maximize the difference between tax and monitoring costs per individual, subject to inducing agents to pay taxes at home. The optimal policy in this region is obtained with a constrained cost minimization problem.

In the region of income levels where the government allows evasion and collects fines, it will maximize the difference between fines and costs of monitoring agents who choose to evade.

We show in the following paragraphs that in the region of compliance the net benefit from collecting taxes, $T - m(\pi^T(y))$, is decreasing in y. In the region of tax avoidance, the monitoring policy of evaders, π^F, will not depend on income, and the net benefit will be constant.

Proposition 8 *There exists a cut-off level of income, $\hat{y}$, such that the optimal monitoring policy for community 1 takes the following form:*

$$\pi(y) = \begin{cases} \pi^T(y) & = & \frac{u(y-T_2)-u(y-T_1)}{u(y-T_2)-u(y-T_2-F)} & \text{if } y < \widehat{y} \\ \pi^F & = & m'^{-1}(F) & \text{if } y \geq \widehat{y}. \end{cases}$$

Proof.

Step 1. In the compliance region, since monitoring is costly, the local government will not monitor in excess. The government sets $\pi(y)$ in this region, such that:

$$u(y-T_1)-(1-\pi^T(y))u(y-T_2)-\pi^T(y)u(y-T_2-F) = 0.$$

Thus

$$\pi^T(y) = \frac{u(y-T_2)-u(y-T_1)}{u(y-T_2)-u(y-T_2-F)}.$$

This expression is increasing in income:

$$\begin{aligned} \frac{\partial \pi^T(y)}{\partial y} &= \frac{\left[u'(y-T_2)-u'(y-T_1)\right]\left[u(y-T_2)-u(y-T_2-F)\right]}{\left[u(y-T_2)-u(y-T_2-F)\right]^2} \\ &\quad -\frac{\left[u(y-T_2)-u(y-T_1)\right]\left[u'(y-T_2)-u'(y-T_2-F)\right]}{\left[u(y-T_2)-u(y-T_2-F)\right]^2} \\ &> \frac{\left[u'(y-T_2)-u'(y-T_1)\right]\left[u(y-T_2)-u(y-T_2-F)\right]}{\left[u(y-T_2)-u(y-T_2-F)\right]^2} \\ &\quad -\frac{\left[u'(y-T_2)-u'(y-T_2-F)\right]\left[u(y-T_2)-u(y-T_2-F)\right]}{\left[u(y-T_2)-u(y-T_2-F)\right]^2} \\ &= \frac{\left[u'(y-T_2-F)-u'(y-T_1)\right]\left[u(y-T_2)-u(y-T_2-F)\right]}{\left[u(y-T_2)-u(y-T_2-F)\right]^2} > 0. \end{aligned}$$

Step 2. In the avoidance region, the optimal monitoring policy solves

$$\max_{\pi^F(y)} N_1 \int_{\hat{y}}^{\overline{y}} \left[\pi^F(y)F - m\left(\pi^F(y)\right)\right] \phi_1(y)dy.$$

The first-order condition,

$$F = m'\left(\pi^F(y)\right),$$

implies that $\pi^F = m'^{-1}(F)$ is constant.

Step 3. In order to find the level $\widehat{y}$ above which the government allows evasion, the following problem is solved:

$$\max_{\widehat{y}} \int_{\underline{y}}^{\widehat{y}} \left[T - m(\pi^T(y))\right] \phi(y)dy + \int_{\widehat{y}}^{\overline{y}} [\pi^F F - m(\pi^F)]\phi(y)dy.$$

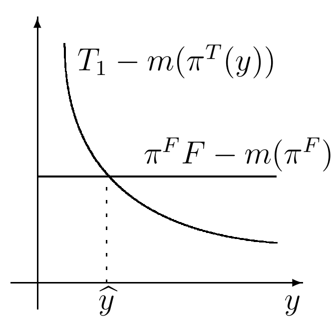
The first-order condition is given by

$$T - m(\pi^T(\widehat{y})) = \pi^F F - m(\pi^F).$$

The left-hand side is the net marginal benefit from compliance, and it is a strictly decreasing function of y. The right-hand side is the net marginal benefit from expected fines in the avoidance region, and it is a constant function. The level $\widehat{y}$ is thus uniquely defined. ■

The determination of the cut-off level, $\widehat{y}$, is shown in Figure 5.

Figure 5: Determination of $\widehat{y}$



Given that the large community's tax rate, T_1, is not guaranteed to be equal to the term $\pi^F F$, the expected benefit from evaders, the schedule $\pi(y)$ can admit discontinuities at the cut-off level, $\hat{y}$, but only in downward jumps, since community 1 could improve by saving on monitoring costs if $\pi^F > \pi^T(y)$. Also, although we have characterized an interior solution for the cut-off point, $\hat{y}$, it may be optimal to prevent evasion for all income levels if $T_1 - m\left(\pi^T(\overline{y})\right) > \pi^F F - m\left(\pi^F\right)$, and in that case the monitoring schedule would coincide with $\pi^T(y)$.

6 Conclusion

The model developed in this paper examines tax competition in a framework with residence-based taxation in which authorities can only imperfectly monitor the origin of tax payers who may choose to evade local taxation by pretending to be residents of the rival low-tax community. We characterize the properties of equilibria in pure strategies when communities differ in size and find that small communities have advantages in capturing some tax base from their rival by undercutting their higher tax rate.

We also characterize the problem facing individual residents who evaluate the payoffs of complying with local taxation and the resulting lottery of evasion. Decreasing risk aversion implies that only high-income agents can afford to choose the evasion lottery. This feature is comparable to existing modeling strategies in spatial frameworks of cross-border shopping, where risk-neutral individuals have unit demands and valuation net of costs of transportation replaces our definition of income.

Our model clearly indicates that integration, in the sense of joint revenue maximization, can always be beneficial from the perspective of local governments. If communities have a way to make side transfers between them, then the minimum tax rate required to generate joint benefits in the harmonization scheme is strictly between the two non-cooperative tax rates. This is important if coordinating to a different tax rate is more costly. Even without side transfers, there are potentially important benefits from harmonization when the minimum agreeable tax rate implies a premium to the small community's non-cooperative tax rate proportional to the fraction of tax evaders in the large community.

In our framework, lump-sum tax policies imply that relatively less risk-averse agents can avoid high taxes by fleeing to another community. This feature makes the head tax structure regressive. Presumably, a federal authority in charge of choosing an optimal tax structure superseding fiscal competition would take into account attitudes toward risk in its design.

In an environment where locations have already committed to a set of tax policies and have to choose monitoring efforts to prevent tax evasion, we show that it may be optimal for a high-tax community to allow some people to evade and that the audit probability should be increasing over the compliance region and constant over the avoidance region.

The implications of the model seem to be in line with some casual evidence for some regions of the United States and preliminary evidence for Uruguay that find statistical correlation between community size and the distribution of car values across municipalities, as well as between size and magnitude of registration fees.

In a more general analysis of policy coordination, particularly between countries, it would be interesting to study the larger version of the game where both tax and monitoring policies can be used strategically. Presumably, even when some type of coordination can be achieved with respect to tax policies, harmonization of monitoring efforts is more costly.

Another question that arises regarding integration of countries is whether allowing for population migration implies some kind of sorting result. In such a framework, we could study the different implications of having borders closed to household migration, as we have done in our model, and opening borders so that individuals who migrate are no longer considered tax evaders. Traditional models of migration of heterogeneous population obtain stratification results in terms of income; in an environment with migration costs, individuals would face the options of evading taxation or emigrating to the low-tax country, and it might be interesting to examine whether stratification still holds.

Appendix

Define

$$U(y,T_1,T_2) = u(y-T_1)-(1-\pi)u(y-T_2)-\pi u(y-T_2-F).$$

Lemma 1 *If (T_1,T_2) are tax rates such that $y_1^* \in \left(\underline{y},\overline{y}\right)$, then* $\left.\frac{\partial U(y,T_1,T_2)}{\partial y}\right|_{y=y_1^*} < 0.$

Proof. Note that $U(y_1^*,T_1,T_2)=0 \Leftrightarrow y_1^* - c(y_1^*,T_1,T_2) = T_1$.
The assumption of DARA implies $\frac{\partial[y-c(y,T_1,T_2)]}{\partial y} < 0$, and therefore $\frac{\partial c(y,T_1,T_2)}{\partial y} > 1$. From the definition of $c(y,T_1,T_2)$, we have $u'(c(y,T_1,T_2))\frac{\partial c(y,T_1,T_2)}{\partial y} = (1-\pi)u'(y-T_2)+\pi u'(y-T_2-F)$, which implies $(1-\pi)u'(y-T_2)+\pi u'(y-T_2-F) > u'(c(y,T_1,T_2))$ for all y.
Finally we have:

$$\begin{aligned}
\left.\frac{\partial U(y,T_1,T_2)}{\partial y}\right|_{y=y_1^*} &= u'(y_1^*-T_1)-(1-\pi)u'(y_1^*-T_2)-\pi u'(y_1^*-T_2-F) \\
&< u'(y_1^*-T_1)-u'(c(y_1^*,T_1,T_2)) = 0.
\end{aligned}$$

The last equality follows from the definition of $c(y,T_1,T_2)$ and y_1^* interior. ■

Proposition 9 *The cut-off income level, y_1^*, defined in equation (2.1) is continuous in* (T_1, T_2).

Proof. It is enough to show continuity for tax policies (T_1, T_2) such that $y_1^* \in (\underline{y}, \overline{y})$. Given tax rates (T_1, T_2), an agent with income y in community 1 decides to evade if $U(y, T_1, T_2) < 0$. Since

$$\left.\frac{\partial U(y, T_1, T_2)}{\partial y}\right|_{y=y_1^*} < 0,$$

by lemma 1; the implicit function theorem then implies that the function $y^*(T_1, T_2)$ such that $U\left(y^*\left(T_1, T_2\right), T_1, T_2\right) = 0$ is continuous in the set of policies (T_1, T_2). ■

Lemma 2 *If (T_1, T_2) is an equilibrium with $T_1 \neq T_2$, then $|T_1 - T_2| > \pi F$.*

Proof. Without loss of generality, let $T_1 > T_2$. Now suppose there is an equilibrium (T_1, T_2) where $T_1 - T_2 \leq \pi F$. Then $T_1 - T_2 \leq \pi F$ implies that $y - T_2 - \pi F \leq y - T_1$ for any y in community 1. Rewriting, we have that $(1 - \pi)(y - T_2) + \pi(y - T_2 - F) = y - T_2 - \pi F \leq y - T_1$. That is, the expected payoff to evading taxes is less than the payoff to paying taxes at home, and no one in community 1 would chose to evade since risk aversion implies $u\left(y - T_1\right) \geq (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)$. Therefore, since $R_2(T_1, T_2) = N_2 T_2$ and $T_2 < T_1 \leq \overline{T}$, it would pay community 2 to raise its tax rate T_2, and therefore (T_1, T_2) could not be an equilibrium. ■

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